2016 MARINE & OFFSHORE

BUSINESS REVIEW

Move Forward with Confidence

BUREAU
VERITAS

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Navigating the storm

In one of the most challenging years the marine and offshore industries have faced, Bureau Veritas focused on providing faster service and added value via two main drivers: digital transformation and a wider scope of services.

2016 turned out to be one of the most difficult years on record for marine and offshore markets.

In marine, dry bulk and containerships, which together make up over half of Bureau Veritas' classed fleet, suffered oversupply, resulting in almost no new orders in 18 months. Tankers fared much better, enjoying increased trade on the back of low oil prices, albeit at lower freight rates.

This turbulence had a major impact on shipyards. A dearth of orders led to yard closures and workforce reductions in Korea and China. European yards, where Bureau Veritas is well represented, remained insulated, thanks to major contracts in the buoyant passenger ship market, as well as for navy and specialist vessels.

> *"The crisis has, and will continue to have, an impact in terms of the concentration of market players. Those who survive will be more demanding, with market requirements for productivity and competitive pricing here to stay."*

Offshore markets were equally hard-hit. With oil prices at rock bottom, most CAPEX projects were put on hold, with the notable exception of FSRUs and smaller FLNG vessels and the emerging Marine Renewable Energies market. As a result, Bureau Veritas focused its efforts on OPEX projects to support owners in optimizing costs and improving asset reliability.

This crisis has, and will continue to have an impact in terms of the concentration of market players. Those who survive will be more demanding, with market requirements for productivity and competitive pricing here to stay. Bureau Veritas has been working for some time to address this need for efficiency via two main drivers: digital transformation, and enlargement of our scope of services.

Efficiency through digitalization

In 2016, our digital transformation launched the previous year fully got off the ground. Key to this transformation is our strategic partnership with Dassault Systèmes to create detailed 3D models of ships and floating offshore units to be used throughout the life of the assets.

During 2016, we slashed design review times via use of this software. With a number of clients, we also developed Veristar AIM^{3D}, a new solution for asset integrity management of complex offshore assets; it goes beyond existing models of asset integrity management and is the next stage in the evolution of our digital services.

Digital transformation is also the opportunity to equip our workforces with tools that improve productivity and help our clients run their fleets more efficiently. Tools such as My Jobs move our surveyors' work from desktop to handheld devices, resulting in faster report delivery and better service. Our clients can now manage their fleet via smartphone, thanks to our new My Veristar app.

We are also working to make our clients' assets and systems more efficient and safe. New simulation software we have developed and piloted with clients targets energy efficiency. And with cybersecurity a growing threat, we are working actively to safeguard your systems, via new guidelines and partnerships.

Broadening our services portfolio

A second driver was the growth in our value-add services, and in the range of clients we are able to serve.

First of all, we are working to make our clients' assets and systems more efficient and safe by addressing their digital components, notably taking into account the growing risks related to cybersecurity. New guidelines and conformity assessments are being produced to address this new scope of class services.

Another dimension is our continued diversification beyond class, with two important acquisitions. TMC Marine improves our coverage for marine insurers and charterers, while MAC adds to our growing portfolio of OPEX services for the offshore market.

Coping with new regulations

Some new environmental regulations are not very popular in the shipping community. On another hand, some analysts believe that the Ballast Water Management Convention and the EU Monitoring Reporting and Verification regulation will accelerate fleet renewals by increasing scrapping and reducing overcapacity, thereby contributing to market recovery. Whatever the perspective, these regulations come into force in 2017 and owners and operators need to be ready to meet them. As always, we will assist to help understand the requirements, identify the right solutions, and achieve compliance.

Safety and performance

As we face the uncertainties and challenges of 2017 and beyond, our focus is to provide clients with the support they need – how, where and when they need it. We will continue to focus on helping clients meet their performance requirements while reducing risk and enhancing safety.

We will support our traditional clients as we expand into new areas – and we will be sharing the benefits of the breadth of our activities, as well as the strength of the nearly 70,000 people across the Bureau Veritas Group.

The operating environment is challenging but we are seeing new opportunities emerging and we retain our optimism about the outlook for the marine and offshore industries.

Philippe Donche-Gay
President Marine & Offshore Division

About Bureau Veritas'
Marine & Offshore teams

Bureau Veritas is one of the world's leading classification societies and offshore safety and verification bodies. A diverse network of engineers and technologists are dedicated to ship and offshore safety and efficiency.

They set, measure and inspect standards for structures, materials, machinery and operations and share their expertise through advisory and support services and training.

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1
WHO?

2,650 PEOPLE IN MARINE & OFFSHORE

We are experts in our chosen fields: marine surveyors and engineers, naval architects, structural and materials specialists.

The common thread: our thorough knowledge of marine and offshore industries. We continually develop and reinforce our expertise through training, the experience we gain by working with our clients, and our leading-edge research projects.

2
WHAT DRIVES US?

KEEPING OUR CLIENTS' CREW AND ASSETS SAFE, EVERY DAY

Risk is ever-present. Protecting our clients' people, ships and offshore structures from accident drives every decision and action we take. This deep sense of purpose makes us go beyond the scope of individual projects to find new ways to anticipate and manage risk across the industry, promote health and safety, and protect the marine environment.

3
WHAT DO WE DO?

PROVIDE OUR CLIENTS WITH THE SUPPORT AND KNOWLEDGE THEY NEED

Our teams apply their knowledge and expertise every day to help our clients solve complex technical problems, meet regulatory requirements and optimize safety and performance. We develop advanced technology and tools, which we share with our clients.

As a classification society, we bridge the gap between international regulations and ship designers, builders and operators.

By setting rules for ships, offshore structures and onboard equipment, and checking they are met, we contribute to safer seas.

4
HOW DO WE WORK?

HAND-IN-HAND WITH OUR CLIENTS

Our clients see us as true partners.

Our relationships are built on years of service, transparency and trust: we work alongside our clients, providing the advice and calculations they need, and sharing our knowledge through training and technology. We work closely with the entire marine and offshore community: designers, yards, equipment manufacturers, contractors, shipowners, oil majors and administrations around the world.

5
WHERE?

CLOSE TO OUR CLIENTS, WHEREVER THEY ARE

We operate as a global network, following global standards, but able to react to our clients' needs locally. With 16 regional plan offices, five offshore technology centers, three research centers and 180 survey offices, we are always within reach. Information-sharing platforms across our network and with our clients, combined with our open, transparent way of working, mean we are set up to manage projects internationally.

6
WHAT MAKES US DIFFERENT?

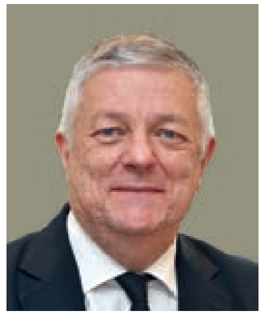
OUR COMMITMENT TO THE MARINE AND OFFSHORE INDUSTRIES

We are deeply involved in the marine and offshore industries.

We seek to share our knowledge widely, and use our extensive work with clients, industry bodies and authorities to bring about positive change. Our people are proud of the role they play in creating long-term value for our clients, supporting innovation and helping the industry move forward safely. In return, our clients recognize and value our commitment to service and technical excellence.

PHILIPPE DONCHE-GAY
PRESIDENT

MATTHIEU DE TUGNY
SENIOR VICE-PRESIDENT,
OFFSHORE ACTIVITIES



ALAIN LE MITH
VICE-PRESIDENT,
MARINE OPERATIONS
DIRECTOR

Marine & Offshore Executive Committee

At January 31, 2017

Bureau Veritas' Marine & Offshore business is driven by an Executive Committee.

The people who make up this executive team are international in outlook, with strong engineering and business backgrounds and experience. They oversee the development of our rules, research activities and value-added services as well as steering a business that encompasses 2,650 people worldwide.

Our priority is to deliver fast, efficient services to our customers. With that aim, our Executive Committee is leading a digital transformation of our business, introducing new tools and services while ensuring our systems, and those of our clients remain secure.

FABRICE LASSALLE
FINANCE
VICE-PRESIDENT

JEAN-FRANÇOIS SEGRETAIN
VICE-PRESIDENT,
MARINE TECHNICAL
DIRECTOR

KEVIN JARMAN
CEO,
MATTHEWSDANIEL

PATRICK LE DILY
VICE-PRESIDENT,
LEGAL, COMPLIANCE
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NICHOLAS BROWN
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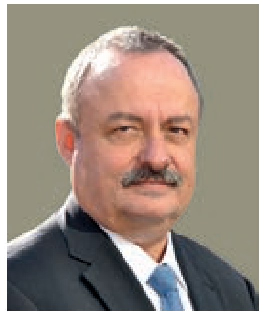
PAILLETTE PALAIOLOGOU
MARINE COMMERCIAL
DIRECTOR

CLAUDE MAILLOT
SENIOR VICE-PRESIDENT,
NORTH ASIA ZONE



DIDIER BOUTTIER
SENIOR VICE-PRESIDENT,
SOUTH EUROPE,
MIDDLE EAST
& AFRICA ZONE

KEREM KIPER
SOUTH ASIA ZONE
VICE-PRESIDENT

HERMAN SPILKER
NORTH EUROPE ZONE
VICE-PRESIDENT

A year of innovation

In 2016, Bureau Veritas put digital transformation and technical innovation at the service of its clients, improving speed of service delivery, optimizing OPEX, and de-risking new technologies. We also broadened the scope of our services.

3D MODEL SLASHES DESIGN REVIEW TIMES ①

A strategic partnership with France's Dassault Systèmes has enabled Bureau Veritas to cut structural computational and design approval times for new vessels and floating offshore units from two months to two weeks. Based on the 3DEXPERIENCE platform, the new software builds a detailed 3D model of the proposed vessel which links directly to Bureau Veritas' entire Veristar suite of calculation tools.

DIGITIZED ASSET INTEGRITY MANAGEMENT

Veristar AIM^{3D}, a holistic digital asset integrity management solution, will launch in Spring 2017, following successful pilot projects with offshore clients. A 3D model of the asset, built using the Dassault Systèmes platform, is updated throughout the life of the asset to provide a continually evolving virtual model. The tool aims to improve safety while reducing maintenance costs throughout the lifecycle.

ACQUISITIONS BOOST VALUE-ADD SERVICES ②

Two acquisitions enabled us to broaden our value-add services, and the range of clients we are able to serve. With focuses on marine claims and accident investigations, salvage and wreck removal consultancy and marine expert witness services, TMC Marine improves our coverage of marine insurers and charterers. MAC, meanwhile, complements our growing portfolio of OPEX services for the offshore market with recognized strengths in dynamic positioning, marine assurance and naval architecture.

①

© D.R.

②

EU MRV ACCREDITATION

Bureau Veritas has gained accreditation from UKAS to carry out assessments for compliance with the EU's Monitoring, Reporting and Verification (EU MRV) regulation. EU MRV requires operators to measure and report on CO_2 emissions based on ship fuel consumption. It applies to all merchant ships of 5,000 GT or above on journeys that call at an EU port. Monitoring begins in 2018.

#1 IN GAS ORDERS

Bureau Veritas became the leading class society for orders of LNG-fuelled vessels in 2016. Notable orders included sister ships for Terntank and Evergas, three dredgers under construction for DEME and a new LNG-fuelled ferry for Brittany Ferries. In addition we will grant our GAS PREPARED notation, designed to future-proof vessels running on traditional fuel, to six Suezmax tankers under construction for Dynacom.

BWM: COUNTDOWN TO COMPLIANCE ③

BWM is the International Convention for the control and management of ships' ballast water and sediments. In force from 8 September 2017, it aims to stop the spread of invasive aquatic species by requiring ships to put in place management plans and treatment systems. Bureau Veritas is working with clients to optimize the cost of BWM implementation and achieve compliance within the deadline.

③

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④

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⑤

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NEW LNG BUNKERING SOLUTIONS ④

Bunkering solutions are key to the development of LNG as marine fuel. In 2016, Bureau Veritas supported development of new solutions. In one of the world's first ship-to-ship LNG bunkering operations, we classed both vessels. We also classed the first ever newbuild LNG bunkering ship co-owned by ENGIE, NYK Line, Mitsubishi Corp and Fluxys. Finally, we certified a novel road tank truck bunkering solution for Seaspan in Canada.

⑥

© DSME

⑦

© Tallink Group

MSC GOES EXTRA-LARGE ⑤

Bureau Veritas' largest order in 2016 was for two extra-large cruise ships from MSC Cruises. Part of the Meraviglia series, the 330m-long vessels will carry 7,685 passengers and crew when they are delivered in 2019 and 2020. They will be built by STX France St Nazaire, which is finalizing construction of the MSC Meraviglia, to be delivered during 2017.

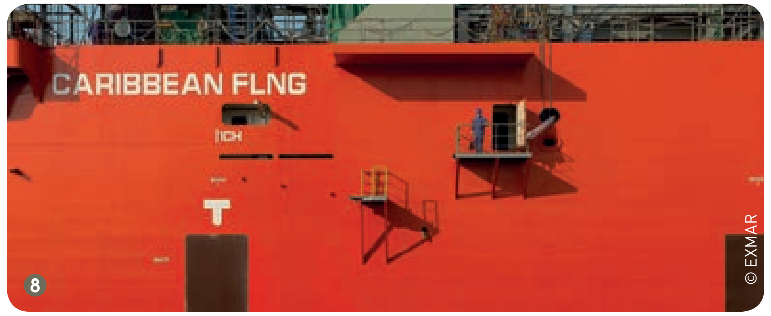
FIRST YAMAL LNG DELIVERY ⑥

The first of fifteen Arctic-capable LNG carriers classed under Bureau Veritas to service the Yamal LNG project was delivered to Sovcomflot in 2016. Built by DSME, it will carry 172,000m^3 of LNG in four membrane tanks. 2016 also saw the order of new vessels chartered to the Yamal project: two 44,000 dwt Polar Class gas condensate tankers for Dynacom.

MEGASTAR SETS PASSENGER FERRY FIRST ⑦

In January 2017, Estonian ferry operator Tallink took delivery of the 49,000 gt Megastar, built at the Meyer-Turku yard in Finland. The first ever LNG-fuelled high-speed ferry, it is designed to operate in icy waters and will shuttle up to 2,850 passengers between Helsinki and Tallinn. The ferry is also the first for Tallink to feature Safe Return to Port.

⑧



© EXMAR

DELIVERY OF EXMAR FLNG ⑧

Exmar's Caribbean FLNG, the world's first FLNG unit, was commissioned and successfully performance-tested in China. The FLNG has capacity of 16,100m^3. An FSRU, also classed with Bureau Veritas, will be delivered in 2017 for Exmar.

FRAME AGREEMENT WITH FPSO LEADER

Bureau Veritas worked on a new standardized design for an FPSO ("Fast4ward") for SBM Offshore, the market leader in FPSO leasing. Following the success of this project, we signed a frame agreement with SBM covering CAPEX and OPEX services.

CERTIFICATION OF NEW TECHNOLOGIES

Bureau Veritas supports industry innovation through type certification of new technologies. In 2016, we signed a frame agreement with Cybernetix, a TechnipFMC company, to certify new technologies including robots, monitoring systems and auxilliary systems for Remotely Operated Vehicles (ROVs). We are particularly active in Marine Renewable Energy (MRE): in 2016 we published a dedicated certification scheme for MRE technologies, and certified three new floating technologies including a floating foundation for a wind turbine in Europe.

Marine & Offshore
worldwide presence

The downturn in both shipping and offshore markets impacted activity worldwide; nevertheless, sectors such as passenger ships, tankers, and LNG projects remained buoyant. Offshore operators looking to preserve or extend the life of their assets also turned to Bureau Veritas for cost-effective asset integrity management.

AMERICAS

The major downturn in offshore in the Gulf of Mexico proved a drag on the region as a whole, with around 60 floaters and 30 jackups retired in the last two years; this in turn hit offshore service vessels. In South America, Bureau Veritas expanded some services, for example design review and conformity assessment of drilling and completion equipment, for which we issued 50 certificates in 2016.

Passenger ships remained the region's bright spot. Canada's Seaspan Ferries took delivery of British Columbia's first LNG-fuelled ferry. We also agreed to provide classification services to BC Ferries for new ferries for near-coastal navigation, and to provide second-party services to a major cruise company. Finally, containerships and bulk carriers saw some activity despite low charter rates. Tropical Shipping ordered six new containerships; and Foremost Group in New York took delivery of the first two of a total of six bulk carriers built at Oshima in Japan.

EUROPE

Shipbuilding was under pressure across Europe, but specialization and a focus on quality attracted orders. The largest was for two extra-large cruise ships for MSC; other orders came from Ponant (expedition cruise vessels); Viken Shipping (oil tankers) Arklow Shipping in Ireland (eco bulk carriers) and Thun Tankers in Sweden. Bureau Veritas will also class the Mediterranean's first LNG-fuelled passenger ferry, under construction at La Naval for Balearia.

Class transfers were also a major theme of 2016: German owner Reederei NSB, for example, moved 12 containerships to BV class.

In offshore, Independent Verification Body (IVB) and certification services were in demand in the North Sea, albeit with demands for price efficiencies and scope optimization. We signed new frame agreements with Total and NOV Elmar and extensions with Shell, Dana Petroleum, Fairfield Energy and Petrofac. Bureau Veritas also supported three new offshore projects via IVB services for initial suitability: Cygnus (ENGIE), Scolty/Crathes (EnQuest) and Laggan-Tormore (a consortium led by Total). Decommissioning of ageing assets is rising up the agenda: Bureau Veritas is providing IVB services to Shell for the decommissioning of the Brent platforms and to Fairfield Energy for the Dunlin platform. We are also providing marine assurance to BP for the decommissioning of the Miller platform.

MIDDLE EAST AND AFRICA

Large ongoing projects and the dominance of national oil companies made the Middle East the most resilient region in the face of the oil price slump. In the Emirates, demand is growing for certification of diving systems and deck cranes on board vessels following new regulations: Bureau Veritas' client Mutawa Marine was the first to get certified in 2016. We also classed a new 420m floating bridge over the Suez Canal in north-eastern Egypt.

Demand grew for classification services in Iran. Bureau Veritas is one of the leading class societies in Iran, with around 20% of the country's classed fleet. Having maintained strong relationships with Iranian shipowners, we classed 22 vessels in 2016. This included reclassification of vessels for NITC and IRISL Group.

Offshore Africa, the Moho Nord FPU was installed offshore Republic of Congo, while work continued on the conversion of two VLCCs to FPSOs for Total and its partners at the Kaombo field offshore Angola.

ASIA-PACIFIC

Shipbuilding was in crisis, with deliveries delayed or cancelled and new orders falling sharply: by around 80% in China, and 30% in Korea. Tankers fared better than containerships: Bureau Veritas is to class six dual-fuel chemical tankers for Furetank Rederi, under construction at AVIC Dingheng, and six oil tankers for IRISL Group of Iran, to be built at HMD. Amongst others, important deliveries included three containerships for CMA CGM, built at SHI, and one VLCC for Chinese owner Landbridge, built at Dalian.

South Asian countries sought effective ways to exploit their offshore reserves including marginal fields. In Malaysia and Brunei, this included the conversions of tankers to FPSOs or FSOs: MISC's MaMPU 1 is a prime example. Offshore operators also turned to Bureau Veritas for asset integrity services.

With demand for LNG set to grow, orders and deliveries of LNG carriers and floating units were buoyant: Petronas, MISC and Bumi Armada are pursuing aggressive FLNG and FSRU strategies. Bumi Armada completed the conversion of their first ever FSU, the Armada LNG Mediterrana. A number of projects are under discussion in Indonesia and some major LNG carrier projects were delivered including the first carrier for the Yamal LNG project built at DSME and the Prachi, chartered by Petronet LNG in India and built at HHI.

Digital
power

Marine and offshore industries are evolving rapidly, with new digital tools improving efficiency. Bureau Veritas has invested to support clients in this industry-wide transformation.

3D models for plan approval…

Our groundbreaking partnership launched in 2015 with Dassault Systèmes yielded two major developments in the way we work with our clients.

The first is a powerful tool that builds a detailed 3D model of the proposed vessel, and generates the models required to assess structure, seakeeping and stability for classification, including the automatic generation of FEM model. As a result, our Local Plan Approval Offices using this tool are able to both improve the accuracy of our calculations, and slash design verification times from around three months to under four weeks.

> *“Veristar AIM³ᴰ is a holistic asset integrity management solution in which a 3D model is updated throughout the life of the asset to provide a continually evolving digital twin.”*

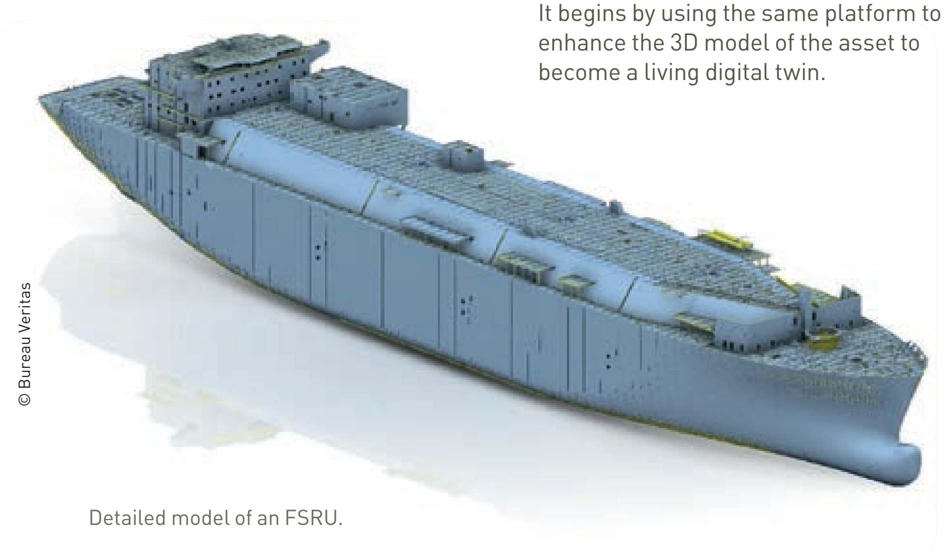
…and throughout the life of the asset

The second is our flagship Veristar AIM³ᴰ solution, a holistic asset integrity management tool launched with selected offshore clients during 2016. It begins by using the same platform to enhance the 3D model of the asset to become a living digital twin.

Inspections can then be prepared in advance with clearer focus on what needs to be inspected, when and why. Updating the digital twin with inspection results will be automatic. Following the pilot project with Total, a first commercial breakthrough with PTTEP, Veristar AIM³ᴰ will be launched to the wider market in Spring 2017.

Certification of new technologies

Certification of new technologies in offshore, including subsea and marine renewable energies (MRE), de-risks projects and supports industry adoption and standardization. In 2016, we worked on certifying an inspection robot for TechnipFMC subsidiary Cybernetix, and signed a frame agreement for certification of other new subsea technologies. We also certified new Managed Pressure Drilling (MPD) technology for Roxel Products in Norway. In MRE, we published a dedicated certification scheme for MRE technologies and type certified three new floating technologies.



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Detailed model of an FSRU.

Detailed information on our digital transformation initiatives can be found in our 2016 Digital Transformation *report, also available online.*

LNG
as fuel

Bureau Veritas leads the market for new orders. 2016 saw a strong increase in gas-fuelled projects, as owners sought to comply with emissions requirements, and advances in ship-to-ship bunkering removed obstacles to adoption.

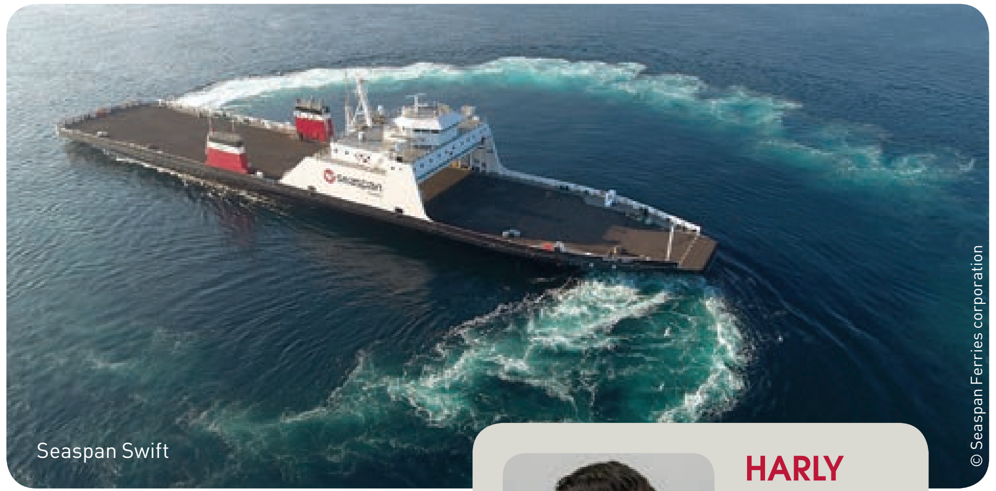
It was also the year that major BV-classed projects were delivered, including an asphalt carrier and a chemical carrier for Groupe Desgagnés in Canada; three tugs for Østensjø in Norway, and two notable ferry projects. The Megastar, a 2,850 pax ship for Estonian operator AS Tallink, is the largest LNG-fuelled passenger ferry in the world. And two LNG-fuelled ro-ro vessels were delivered to Seaspan in Vancouver, Canada. They feature hybrid propulsion with lithium-ion e-batteries onboard. Based on the increase in new projects with hybrid propulsions, we are preparing the Hybrid Notation.

Innovative bunkering

2016 saw a number of firsts in LNG bunkering. In one of the world's first ship-to-ship bunkering operations, in the port of Gothenburg, Bureau Veritas classed both vessels: Terntank Rederi's M/T Ternsund, the world's first LNG-fuelled newbuilding chemical tanker, bunkered LNG from Coral Energy.

We also led the development of IACS bunkering guidelines and chaired the working group for SGMF bunkering guidelines bringing to the industry the necessary framework for securing safety during bunkering operations.

We were deeply involved in ship-to-ship bunkering via classification of the first-ever newbuild LNG bunkering ship. Delivered in 2016, the 5,100m^3–capacity vessel is co-owned by ENGIE, NYK Line, Mitsubishi Corp, and Fluxys. Another bunker vessel is under construction for Sirius Veder Gas AB.



Seaspan Swift

© Seaspan Ferries corporation

New orders and technologies

New orders came in the form of sister ships for Terntank and Evergas, but also new designs. We are classing the first LNG-fuelled vessels in a number of segments. These include dredgers, in the form of three vessels under construction for DEME plus one new order, the largest LNG-fuelled dredger cutter; and the conversion to LNG fuel of a container feeder vessel for Wessels Reederei. We will also class a new LNG-fuelled ferry for Brittany Ferries.

Beyond class, MSC Cruises awarded Tecnitas a contract to deliver LNG consultancy to technically support the owner on the design of the LNG propulsion for a new innovative large LNG-fuelled cruise liner project.

HARLY PENNER

PORT ENGINEER, SEASPAN FERRIES CORPORATION

Seaspan Ferries Corporation operates a fleet of seven ferries in British Columbia, and supplies more than 50% of all cargo to Vancouver Island. In December we took delivery of the Seaspan Swift, the first of two new hybrid ferries in our fleet replacement program. The Seaspan Swift is the world's first hybrid LNG/battery-powered ferry, and also the first to use bunkering on-board from a truck trailer. As such, it was vital to have a class society with strong expertise in LNG who understands our requirements. Bureau Veritas, with its dedicated LNG team, really went above and beyond.

Numerical simulation moves center stage

Bureau Veritas' research partnerships with academics, technology companies and marine and offshore clients led to the development of new methodologies and improved tools.

Creation of Ship of the Future research chair

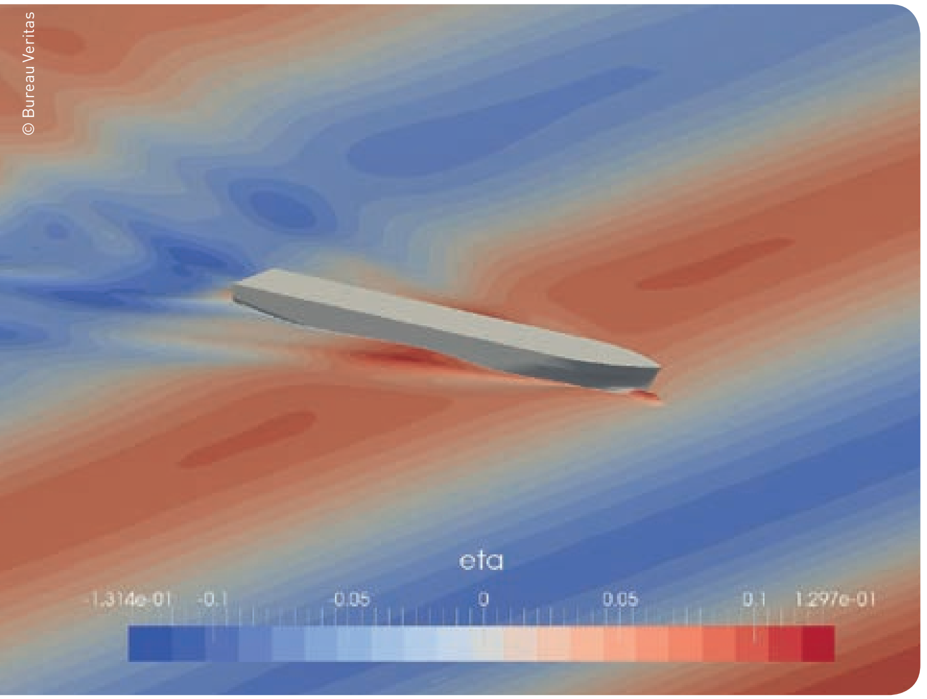
Bureau Veritas established an international research chair with leading French engineering school Centrale de Nantes, Nextflow Software and HydrOcean, a Bureau Veritas company specializing in hydrodynamics. The Chair in Hydrodynamics and Marine Structures aims to achieve significant improvements in ship safety and performance.

The work of the Chair is focused on three complementary areas: the development of numerical simulation tools; their validation in the testing facilities of Ecole Centrale de Nantes, which are among the best in Europe; and developing efficient methodologies for dealing with hydrodynamic and hydro–structural issues. The latter builds on Bureau Veritas' strong background in hydro-structural coupling, and the partners' experience in Computational Fluid Dynamics (CFD).

The research programs are designed to achieve higher complexity and accuracy in modeling flow. Specifically, they seek to provide better modeling in the case of non-linearities such as viscosity and high forward speeds. They also seek to create accurate numerical models for seakeeping applications in severe sea states. Specific research topics range from the effects of green water to the structural response of the hull girder to slamming.

Bureau Veritas also developed its own version of the OpenFoam CFD software (FoamSTAR) which includes features relating to coupling with the structure.

> *"The Chair created in partnership with* Ecole Centrale de Nantes *in Hydrodynamics and Marine Structures aims to achieve significant improvements in ship safety and performance."*



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Containership at speed in regular waves.

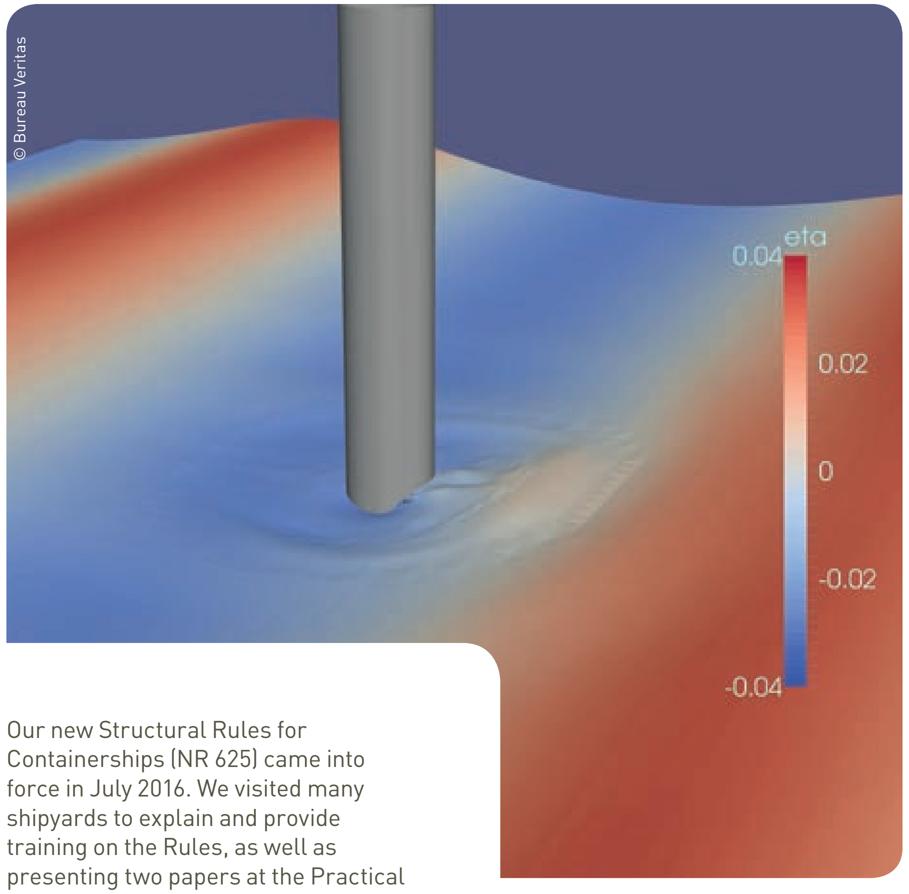
Non-linear roll JIP promotes more accurate designs

We completed a Joint Industry Project with Petrobras and Marintek on non-linear roll. The aim: to develop models and methodologies to compute non-linear roll motions for FPSOs.

Long roll periods are observed for large FPSOs, which are subject to second order excitation. The JIP addressed this by updating Bureau Veritas' HydroSTAR model and by developing methodologies on how to use the simulation tools to ensure that the highest loads and roll motions are calculated. It also updated empirical models for roll damping due to the bilge keels. The results of the JIP are intended to feed into more accurate designs for FPSO structures.

New rules and certification schemes

We published new ship classification rules to integrate IMO regulations that came into force in January 2017. New ships using gas or other low-flashpoint fuels need to comply with the requirements of the IGF code, which contains mandatory provisions for the arrangement, installation, control and monitoring of machinery, equipment and systems. Our updated NR 529 "Gas-Fuelled Ships" helps owners and yards understand and comply with the new IMO regulations, with more than 100 Bureau Veritas interpretations and clarifications. IMO's adoption of the Polar Code also resulted in updates to BV class rules NR 527, which will mainly impact the growing expedition passenger ship market.



© Bureau Veritas

Diffraction by a vertical cylinder.

Our new Structural Rules for Containerships (NR 625) came into force in July 2016. We visited many shipyards to explain and provide training on the Rules, as well as presenting two papers at the Practical Design of Ships (PRADS) conference. In each case, we were keen to emphasize the technical approach we used: computations on around 60 ships provide robust reference data including realistic loads, to enable more accurate calculations for structure. Thanks to the precision it offers, we are increasingly moving towards this approach to rules development, based on direct computations rather than an empirical approach.

In offshore, we published new diving system certification guidelines in response to requests from clients. These cover both surface-supplied and saturation diving systems and complement our earlier rules for the classification of diving support units. Also in offshore, we issued new rules for jackups (NR 534) and semi-submersibles (NR 571).

> *"We are increasingly moving towards rules development based on direct computations as opposed to an empirical approach."*

In a difficult market, owners seeking fast service and technical and regulatory expertise transferred their ships to BV class: around 300 by end-2016. Our recognized experience in LNG-fuelled projects also attracted new orders across segments as diverse as passenger ships, tankers and tugs.

©Tallink Group

MARINE ACTIVITIES

18 **PASSENGER** SHIPS
20 **GAS** CARRIERS
22 **OIL & CHEMICAL** TANKERS
24 **BULK** CARRIERS
25 **CONTAINERSHIPS**
26 **WARSHIPS**
27 **TUGS**
28 **DREDGERS**
29 **INLAND** NAVIGATION

Extra-large ships meet market demand

Passenger ships bucked the wider shipping industry trend, with a record year for new orders. Operators continued to choose BV class, thanks to our reputation for safety and our expertise in gas-fuelled vessels.

Favorable demographics in the US and Europe, combined with new destinations, continued to boost the cruise line industry in 2016. New large ships over 120,000 gt dominated order books, but operators also invested in improvements to existing ships, and in new small-size polar expedition vessels that comply with the recently-adopted Polar Code. Orders for ferries also held up well, as operators replaced ageing fleets with new, more efficient ships, including gas-fuelled vessels.

The Bureau Veritas classed fleet increased to 3.75 million gt thanks in part to deliveries of larger ships. As shipowners and operators focused on passenger safety and comfort, and sought expertise in gas fuel, Bureau Veritas' order book for passenger ships and ferries totaled 1 million gt at end-2016.

CAPTAIN TARVI-CARLOS TUULIK

CEO, TALLINK

Bureau Veritas classed the Megastar, a fast, quiet LNG dual-fuel ferry with an efficient hull shape. We are very happy with its performance since delivery in January 2017. Even though the vessel is around 30% larger than our previous shuttle ships, energy consumption looks to be lower in the first few weeks of operation. From design through construction, we valued Bureau Veritas' flexibility and support. The most challenging part of the project was the Safe Return to Port requirement. Bureau Veritas was always onboard, working across multiple sites: they were there when we needed them and co-operation with their specialist LNG team in Paris worked well.

Artist view of the "Le Laperouse", the first of a series of 4 expedition cruise ships in Ponant's Explorer class ordered at Vard shipyards in Norway.

© Ponant & Sterling Design International

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CRUISE SHIPS
ON ORDER TO
BV CLASS

Going extra-large with MSC

By far the largest order was for two extra-large cruise ships from longtime customer MSC Cruises. Part of the Meraviglia series, they will feature an extended length of 330m, and total 177,000 gt, enabling each ship to safely carry 7,685 passengers and crew when they are delivered in 2019 and 2020. Bureau Veritas is working closely with STX France Saint-Nazaire and MSC on designs for these new vessels, as well as on the final stages of construction of the MSC Meraviglia, which will be delivered towards the end of Spring 2017.

Supporting growth in Arctic cruises

Having taken part in the development of IMO's Polar Code, which came into force in January 2017, Bureau Veritas is well placed to work on sophisticated expedition cruise vessels. We were chosen by Ponant to class their four new luxury "explorer class" cruise ships ordered at Vard in Norway, for delivery in 2018 and 2019. Each 10,000 gt vessel will be able to carry 184 passengers, and is unusually flexible: it is designed to operate in the Amazon as well as in Arctic waters.

New record in luxury

In terms of notable deliveries, June 2016 saw the launch of the BV-classed Seven Seas Explorer, presented by owner Regent Seven Seas as the most luxurious cruise ship ever built.
Able to accommodate 758 passengers, it was constructed at Fincantieri Sestri in Italy.

First dual-fuel ferry

Finally, in January 2017, Estonian ferry operator Tallink took delivery of the 49,000 gt Megastar, built at the Meyer-Turku yard in Finland. The first ever LNG-fuelled large ferry fully compliant with the recently adopted IGF Code, it is designed to operate in icy waters and will carry up to 2,850 passengers on a route between Helsinki to Tallinn. The Megastar is also the first vessel for Tallink to feature Safe Return to Port.

© Regent Seven Seas

Seven Seas Explorer, built to BV class and billed as the most luxurious ship ever built.

Demand for LNG driving recovery

Despite the challenges of continued low charter rates and oversupply, the second half of 2016 saw a moderate boost in LNG trade, with increased rates and tighter fleet availability in the Atlantic basin.

© Samsung Heavy Industries

The 175,000 m^3 LNG Abalamabie for NLNG, built to BV class by South Korea's Samsung Heavy Industries yard.

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GAS CARRIERS MOVED TO BV CLASS

The two main segments of the gas carrier market moved in opposite directions during 2016. On the one hand, LNG carriers began to slightly recover in the second half, thanks to long-term demand for clean fuel in emerging countries and a nascent bunkering market boosting smaller-scale LNG. Spot charter rates remained at a very low level over the year, even below 30,000 USD/day for conventional steam turbine LNG carriers.

On the other hand, oversupply and low charter rates continued to dog the LPG carrier market. The trend in recent years for owners to replace smaller vessels with carriers over 80,000m^3 has resulted in fleet volume increasing by over a third, depressing the market for newbuildings.

© HHI

The 173,000 m^3 LNG carrier Prachi built by HHI to BV class and delivered in November 2016.

In this challenging market, owners recognized Bureau Veritas expertise, particularly in small scale LNG and membrane LNG carriers. The classed fleet grew 9% to reach 263 ships. This growth included 16 transfers to BV class.

In terms of regulations, the IGC code entered into force in July 2016. Other than slight modifications to design, compliance for gas carriers should be relatively simple thanks to clean cargo and more evolved technology.

Ice trials underway

The first of 15 Arctic-capable LNG carriers classed under Bureau Veritas to service the Yamal LNG project was delivered and in Spring 2017, it began ice trials in the Arctic. The 300m-long vessel, owned by Sovcomflot and built by South Korea's DSME, will carry 172,000m^3 of LNG in four membrane tanks of GTT 's NO96 design. With Bureau Veritas' winterization notation COLD, the hull is prepared for operation in -45° Celsius ambient temperature and the equipment will be able to work at -52° Celsius.

Supporting LNG bunkering

As shipping companies transition to using LNG as fuel, the first-ever newbuild LNG bunkering ship with a capacity of 5,100m^3 performed final sea trials in 2016. Built at Hanjin, the vessel is co-owned by ENGIE, NYK Line, Mitsubishi Corp, and Fluxys. Bureau Veritas assessed the LNG transfer system, which follows the requirements of our LNG Bunkering Ship notation (NR 620) published in 2015 and will provide an attestation of compliance.

A Sirius Veder Gas AB new bunker vessel is also under construction at Royal Bodewes. The vessel, chartered by Skangas, will carry 5,800m^3 of LNG in two type C tanks from end-2017.

Bureau Veritas also supported the adoption of LNG fuel through the classification of both vessels in the world's first ship-to-ship LNG bunkering operation between two independent ocean-going vessels. The bunkering operation between Terntank Rederi's M/T Ternsund and Coral Energy, a Dutch small scale LNG vessel owned by Anthony Veder and chartered by Skangas, took place in Gothenburg.

SHIGEHARU YAJIMA

SENIOR VICE PRESIDENT, OIL & GAS BUSINESS, INPEX

Ensuring a stable supply to our major customer CPC Corporation from Ichthys LNG, Taiwan required an LNG carrier with an extremely large cargo capacity. At 182,000m^3, our vessel will have the largest Moss-type cargo tank capacity of any LNG carrier in the world. We went through a careful process to select a classification society: Bureau Veritas has a strong reputation, track record and experience. They are our eyes and ears to scrutinize construction of the vessel, they proactively engage with our teams, and we have been consistently impressed by them.

Focused on industry development

With demand for low-sulphur fuel growing as a result of Emission Control Areas, Bureau Veritas continues to focus on small-scale LNG ships as well as newbuild and converted FSRUs. We remain close to industry innovation through our participation in industry groups and forums. As members of the International Gas Union, Bureau Veritas participated in the World LNG Report issued in April 2016, and is working on the next edition, to be launched during Gastech 2017.

Environmental regulations drive orders

A move to cleaner fuels helped support newbuildings in 2016, although low charter rates continue to weigh on the market. Operators continued to choose Bureau Veritas for our tools and rules to meet requirements stemming from regulatory changes.

© Minerva Marine

Greece's Minerva Marine has taken delivery of the 40,000 dwt product tanker Minerva Tychi.

The tanker market remained relatively buoyant in 2016, despite lower charter rates. Major players are promoting clean energy and clean technologies to achieve reduced emissions and fuel consumption in chartered vessels. The Bureau Veritas classed fleet increased to 1,167 ships, in part due to newbuildings using LNG as fuel.

Owners and operators, meanwhile, are beginning to focus on regulatory changes. The Ballast Water Management Convention, entering into force in September 2017, combined with upcoming sulphur emissions limits, is likely to hasten scrapping as owners weigh the cost of compliance, particularly for older vessels.

Tankers breaking the ice

2016 saw a new order for two Polar Class product tankers for Dynacom, chartered to Russia's Arctic-based Yamal LNG. The 44,000 dwt specialized gas condensate carriers feature innovative ice-breaking capability, advanced propulsion and winterization. Two shipyards were involved—Guangzhou Shipyard International in southern China and Arctech Helsinki Shipyard in Finland, which specializes in building vessels capable of operating in Arctic waters.

STAVROS DANIOLOS,

TECHNICAL MANAGER, MINERVA MARINE

Minerva Marine is a vertically integrated ship management company with a relatively young, 65-strong fleet including 60 tankers. We are a growing company and are investing strategically in our fleet. In 2016 we took delivery of a newbuild 40,000 dwt product chemical tanker, the Minerva Tychi: we also acquired a five-year-old VLCC, the Pantanassa. Both were built at Hyundai Heavy Industries to BV class. We have a good relationship with Bureau Veritas' Piraeus office: they are client oriented, with a good technical background that makes them well placed to assist with our existing fleet and with newbuilds.

New tanker design

In September, Greece's Maran Tankers took delivery of the 320,000 dwt VLCC Maran Artemis, built to BV class at Korea's DSME yard. The 330m-long double-hull crude oil tanker boasts a new design with structural innovation in the central tank. Bureau Veritas was first brought on in an advisory role: this is the first tanker for Maran under BV class.

Growth in gas-as-fuel

The number of BV-classed gas-fuelled projects continues to grow, with notable projects including Furetank Rederi's six 16,300-dwt modern-layout chemical tankers. The ships are being built at China's Avic Dingheng shipyard and have an expected delivery date of 2018.

Bureau Veritas is also to grant GAS-PREPARED notation to six Suezmax tankers under construction for Dynacom, the first shipowner to future-proof its vessels by applying for the notation. The 157,000 dwt tankers are being built at New Times Shipbuilding in China, with delivery in 2017 and 2018.

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NEW ORDERS
TO BV CLASS

Leader in asphalt

Bureau Veritas has gained a leading position in both fleet and order book for these specialized tankers.
Six new orders were placed in 2016 with BV class in China and South Korea shipyards. One of these brand new orders is the 37,000 dwt asphalt carrier and oil tanker contracted by Kumiai Senpaku in Chengxi Shipyard.
It is one of the biggest asphalt carriers ever built.

Tools to meet client needs

Updates for H-CSR in the Veristar Hull and Mars tools enabled the approval of new designs, which materialized in a new order for one Suezmax and two Aframax oil tankers. These three vessels are the first large tankers Viken Shipping has ordered to BV class.

We also met the needs of chemical tanker operators through the launch of our new Veristar Chemicals program.

This web application enables users to enter the ship description and generate lists of transportable chemical products in bulk permitted by the IBC code and up-to-date MSC circulars. Ship managers, shipyards or design offices can use the web app to define required features for new ships or see the outcome of proposed modifications.

© Maran Tankers

Maran Artemis, a 320,000 dwt VLCC built to BV class at Korea's DSME yard.

Battening down the hatches

Low charter rates affected the dry bulk segment, resulting in few new orders.

All dry segments suffered from historically low charter rates during 2016, resulting in lay ups and demolitions.

The Bureau Veritas classed fleet remained steady at 1,026 vessels, representing nearly 40.2m gt, thanks in part to its average age of just seven years.

Newbuilding activity was extremely low, but we received orders for three new vessels, representing a total of 84,460 gt.

Classification demand from Iran

In 2016, Bureau Veritas benefited from 36 ships transferred to class or reclassed, including five bulk carriers from IRISL Group. Valuing customer-centric services, reputation and leadership in dry bulk, Iranian owners made Bureau Veritas their "class of choice" to answer growing needs for classification in the country.

Ballast Water Management (BWM)

The BWM Convention is the International Convention for the control and management of ships' ballast water and sediments. In force from 8 September 2017, it aims to stop the spread of invasive aquatic species by requiring ships to put in place management plans and treatment systems that remove organisms, render them harmless, or prevent their discharge into the sea.

Applied retroactively, BWM represents an additional cost for bulk carriers, and in a depressed market is likely to lead to scrapping. Bureau Veritas is working with clients to optimize the cost of BWM implementation and achieve compliance within the deadline.

LILAS software update

Bureau Veritas introduced a new version of its LILAS software, used to compute elastic shaft alignment for large ships, including bulk carriers. This advanced software considers the flexibility of hull and bearing materials performing further calculations for both static and running conditions. The aim is optimum shaft alignment at newbuilding stage and a reduction in probability of damage during operations.

RAFFAELE ZAGARI

CEO, AUGUSTEA HOLDING

The Augustea Group provides sea transportation services in the dry bulk shipping, deep sea towing and oceanic barge transport segments. We operate an extensive ocean-going fleet of owned and chartered-in vessels, including 15 bulk carriers classed with Bureau Veritas: another bulk carrier is under construction. We choose Bureau Veritas for classification thanks to the quality of their technical support, their prompt and competent response to queries and their focus on customer care. Continuous and qualified cooperation at the highest level in supporting our fleet's activities worldwide provides real benefits in terms of safety, environmental, quality and technical performances of both fleet and shore staff.

The 208,000 dwt bulk carrier Star Marisa is one of a series of nine Newcastlemaxes built to BV class.

© Star Bulk

Weathering the downturn

Mergers and alliances failed to resolve market overcapacity issues, making 2016 the worst year on record for both owners and yards.

Freight rates collapsed in 2016, leading to consolidation and alliances among major players, and a dearth of new orders. Looking ahead, the introduction of Ballast Water Management (see opposite) is likely to result in scrapping, paradoxically resolving some of the segment's supply issues.

Transfer to BV class

In a difficult market, owners turned to Bureau Veritas, citing our flexible approach and new digital services developed to optimize efficiency and costs. A total of 37 containerships and 46 cargo ships moved to BV class, contributing to a 9.5% increase in the classed fleet. In an otherwise depressed market for newbuilding, we received an order for six BV-classed vessels from Tropical Shipping.

LNG conversion is sector first

Bureau Veritas is to class the first containership LNG-fuelled conversion: a 1,036 teu vessel owned by Wessels Reederei. The $500m^3$ LNG tank will be located in the fore part of the vessel to limit loss of cargo capacity.

+9.5%
INCREASE
IN CLASSED FLEET
(GT)

Bureau Veritas will class the MV Wes Amelie, the first containership in the world to be converted to LNG fuel.

© Wessels Reederei

New Rules based on robust reference data

Our new Structural rules for Containerships (NR 625) came into force in July 2016 following the publication of IACS UR 11A and UR 34. It is based on computations on around 60 ships. Critical aspects such as ultimate strength, whipping and springing phenomena are included, as well as the effects of anti-rolling tanks on motion and lashing calculations. We introduced 2D structural analysis software MARS NG for assessing hull girder strength criteria and our Veristar Hull software has been upgraded to integrate the new rules, enabling designers to perform yielding, buckling and fatigue assessment easily and accurately.

Software optimizes cargo arrangement

With cargo arrangement representing a major risk in container shipping, Bureau Veritas has developed software that applies the logic of IMO rules, helping clients devise the optimum layout. We implemented the software with two pilot clients, CMA CGM and Starbulk, before rolling it out to the wider market.

Flexibility
and digitalization

Navies around the world continued to invest in multi-role vessels in a world that is increasingly digital, automated, and interconnected.

Growth returned to naval spending bringing opportunity but also increased competition. Demand continues for warships with ever more effective design, construction and operations.

New challenges include increased data volumes, accelerated technology cycles, and growing digital war operations. Bureau Veritas is working with DCNS on a cybersecurity certification project for securing military vessel navigation systems. Additionally, new submarine rules were released in September, with updates for surface ships slated for 2017.

HERVÉ GUILLOU

CEO, DCNS

DCNS is committed to investing in our technologies, and galvanizing the best of our expertise to deliver efficient and competitive vessels for our customers' sovereignty. We have had an active partnership with Bureau Veritas for several years. As an objective third party, Bureau Veritas creates a level playing field. Our export clients appreciate the fact we apply standards that are not just internal or national, and which are updated based on client experience and according to new decisions from IMO.

Front line ships

A total of six FREMM multi-mission frigates were contracted, with four going to France, one to Egypt, and one to Morocco.

Ten BV-classed Gowind® 2500 vessels designed by DCNS are also under construction, including six frigates for the Royal Malaysian Navy, built at the Boustead Naval Shipyard, and four corvettes for the Egyptian Navy—one under construction in Lorient, France, and three in Alexandria, Egypt.

Bureau Veritas classed a 72m polar logistic and patrol icebreaker for the TAAF (French Southern and Antarctic Lands) and the French Navy, and a frigate for the Spanish Navy.

Multi-mission vessels

Flexibility was the key word of 2016 with the French Navy ordering 24m multi-mission barges and a B2M class ocean-going vessel.

France also contracted 70m BSAH support and rescue vessels, while Piriou was contracted to build a 72m BHO2M hydro-oceanographic vessel for Morocco.

Offshore patrol vessels

Thanks to Bureau Veritas's worldwide track record in military ships, the Indonesian Coast Guard chose BV class for its 110m offshore patrol vessels (OPV). This category also saw two OPVs for Tunisia, Guyanese Light Patrol Vessels for the French Navy, and the first of 79 small patrol vessels for Saudi Arabia built by Couach Yard.

© DCNS

Advanced designs
for greater efficiency

Cost control and efficiency were the focus for 2016, as tug operators responded to difficult market conditions via consolidation and joint ventures, and by adopting high performance designs.

Low oil and gas prices and a downturn in major shipping markets spelled a difficult year for tugs. The number of market players reduced as international operators bought smaller local companies, and operators formed joint ventures to boost operational efficiency and access specific geographies.

Nevertheless, following record orders in 2015, a large number of vessels joined BV class. A total of 91 newbuildings and 65 transfers took the total classed fleet to 1,725, cementing Bureau Veritas' leadership position.

Due to strong focus on innovation and industry partnerships, Bureau Veritas has become the classification partner of choice for high performance design concepts, resulting in 90 orders during 2016. These include tugs powered by natural gas, such as the Robert Allan-designed 40m dual fuel ASD escort tug (RAstar 4000 DF) and the Damen RSD 2513 CNG harbor tug.

Hybrid propulsion concepts gain ground

Owners showed growing interest in advanced tug designs, characterized by hybrid propulsion concepts and performance-optimized thruster configurations. Iskes Towage and Salvage took delivery of the BV-classed Telstar, the first Eddy tug 24-75 design featuring diesel-electric propulsion system.

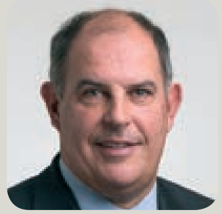
© Robert Allan

VB Xaloc, the first revamped Robert Allan designed TRAktor 3200-V class.

Delivery of high performance escort tugs

In Spain, the first revamped Robert Allan-designed tractor tug (TRAktor 3200-V) was delivered to Spanish owner Boluda: a further nine are on order. Bureau Veritas also classed the new Damen ASD 2913 tug for Saam Smit Towage, a joint venture between SAAM and Boskalis subsidiary Smit.

+6%
GROWTH
IN CLASSED FLEET



ALVARO PLATERO

OWNER AND PRESIDENT, ASTILLEROS GONDAN

Gondan has been building ships for over a century. We currently have three dual-fuelled tugs under construction for Østensjø. Built to a new design, 40m long with 100 tonnes of bollard pull, they will be the first of their type in Europe. For us, it was important to work with Bureau Veritas: not only do we have a longstanding relationship with them, but this is the first time we have built an LNG-fuelled vessel and we were keen to tap into their expertise. They are serious people and we work well together.

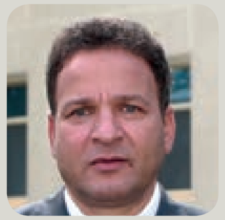
New IMO stability rules

Bureau Veritas supported the towing industry in promoting operational safety by steering the development of the new IMO intact stability requirements for towing and escorting vessels, adopted in 2016. Entering into force in 2020, the new rules are primarily based on the harmonized towing and escort stability criteria developed by Bureau Veritas and published in 2014 as part of the tug guidelines (NI 617). Ahead of the IMO schedule, Bureau Veritas will incorporate the new standards into the core rules in 2017, together with a new family of fit-for-purpose class notations.

Growing demand
for gas fuel and standardization

An uncertain outlook led owners to carefully consider their options in 2016, consolidating their fleets to focus on core assets, while disposing of older, less efficient vessels.

In a difficult market, Bureau Veritas consolidated its leadership in the dredging segment as owners looked for efficient standardized designs and gas-fuelled vessels for operation in emission control areas.



MOHAMED AFAN

SENIOR TECHNICAL DIRECTOR, NATIONAL MARINE DREDGING CO.

NMDC is recognized for its dredging and reclamation expertise. Since the beginning of the decade, our strategy has been to expand geographically, and diversify into new activities including soil improvement, geotechnical analysis, sea and coast cleaning works, ports and marine civil works and circulation channels. Bureau Veritas classes around 80% of our 90-strong fleet in service. We choose them because they are co-operative and reliable: they communicate well, and follow up on time. They are classing our new vessel under construction: a trailing hopper suction dredger that is the first hopper dredger in our fleet.

Environmentally and technologically optimized design

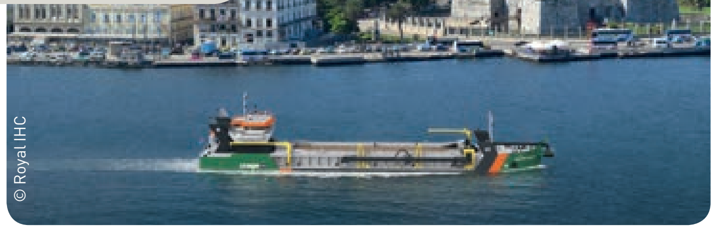
Belgian owner DEME invested in a next-generation LNG-prepared trailing suction hopper dredger, the Bonny River, under construction at COSCO Guangdong under a subcontracting agreement with Royal IHC. With a long suction pipe and a large transport capacity, the concept developed by C-Job can be used in both shallow water and for extraction projects at more than 100m water depth. It features a closed-process water circuit to minimize turbidity generated by overflow water and enable the vessel to dredge in environmentally vulnerable areas.

Demand for standardized designs

Owners targeting efficiency sought standardization. One example was the order by Cuba's Tecnoimport and Empresa Constructora de Obras Marítimas of the Easydredge® 3,700 m³ hopper dredger concept featuring standardized components. The 93m-long vessel,designed and built by Royal IHC, has been upgraded with various options including a dynamic positioning system that will help the vessel navigate through narrow passages and protect the coral reefs along the Cuban coast.

Large dredger deliveries

Two deliveries were notable for their size. At 198m, the Inai Kenanga is the largest dredger ever built in Malaysia, at Selat Melaka. And in the Netherlands, Ravestein delivered Magnor, the world's largest backhoe dredger equipped with three 40m-long spuds, to Boskalis. With a total installed power of 4,100 kW, the Magnor's bucket will be able to lift 67,000 kg of dredged material in a single grab.



© Royal IHC

Cuban Easydredge® 3,700m³ hopper dredger, designed and built by Royal IHC.

Growing demand
for classification

Increasing use of waterways as a transport alternative kept inland navigation afloat in 2016, with innovative projects and new rules.

The asphalt carrier Lapresta, owned by Asphatrans and classed by Bureau Veritas.

© Asphatrans S.A.R.L.

Inland Navigation bucked the wider downturn in the shipping and maritime industry in 2016 thanks to political support for waterway transport. The year saw innovative gas-fuelled and LNG cargo projects, as well as an increase in the use of hydrogen fuel cells. New orders were received for 83 different vessels: a similar number are under construction and will be delivered in the coming months.

With no regulations in place, owners and authorities also turned to Bureau Veritas for inspection of floating structures and equipment following our publication of a new rule note for harbor equipment (NR 612) and published from 2012 rules for Floating Establishment (NR 580). Amongst others, innovative projects included the 420m El-Nasr floating bridge over the Suez Canal.

Many South American countries increasingly require classification for ships operating on inland waterways. In anticipation of client demand, we opened an office in Asuncion, Paraguay, which along with Peru, is beginning to demand classification. We are also expecting orders in Europe, where the new ADN regulation could boost new construction of double hull tankers as the deadline to phase out single-hull ships approaches.

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NEW VESSELS DELIVERED TO BV CLASS

First floating hotel in Paris

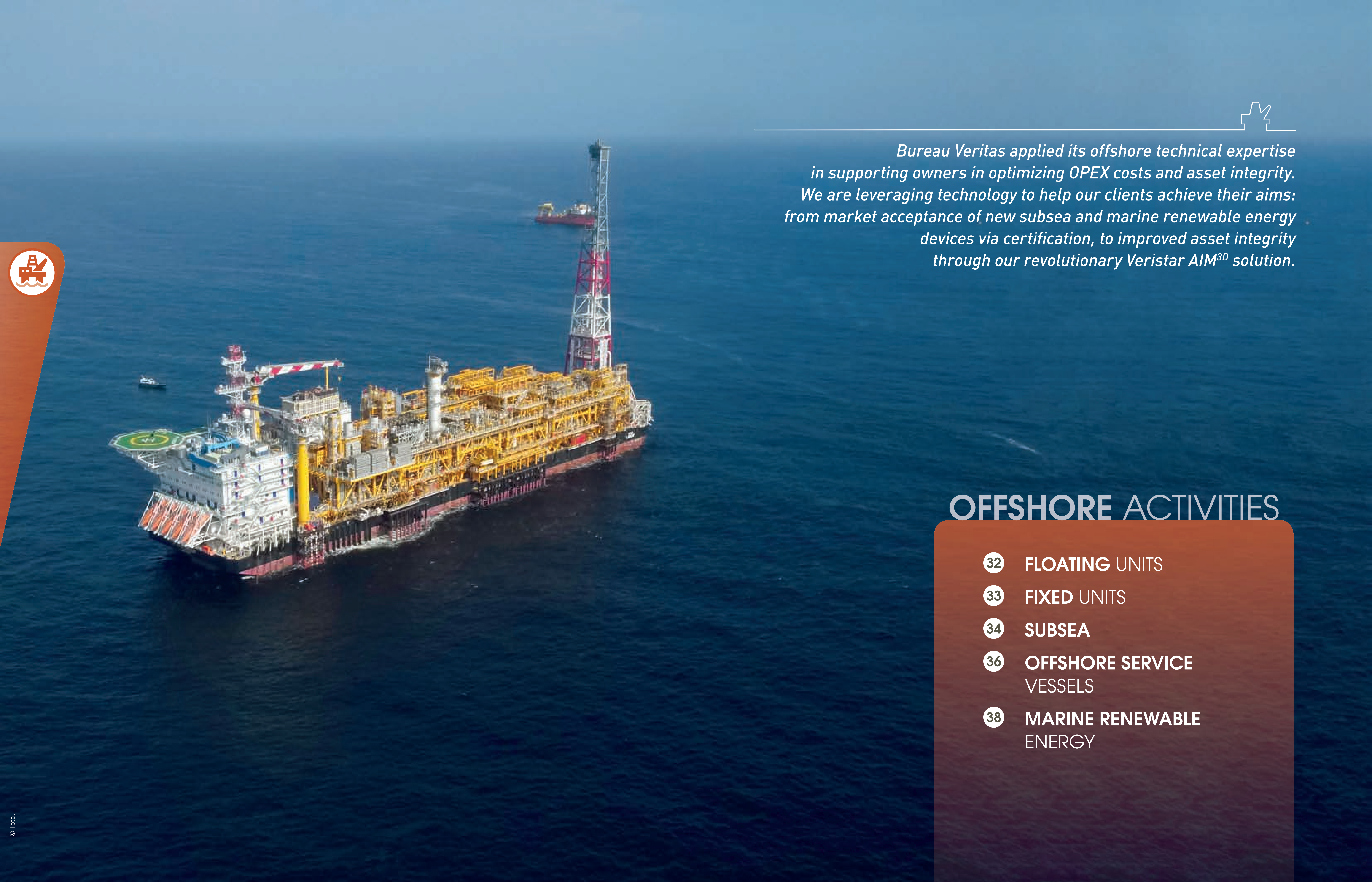
Paris welcomed its first floating hotel on the River Seine, a 75-meter, multi-hull barge articulated with pivot links. Classed under Bureau Veritas Floating Establishment Rules (NR 580), the structure's innovative design raised challenges in terms of stability and its constant mooring position.

An exceptional asphalt carrier

At 7,400 dwt, Lapresta is the largest inland navigation asphalt carrier in the world. Owned by Asphatrans - a CFT and Reederei Jaegers joint venture- the double-hulled vessel is 135 m long with independent 760m³ tanks. The design represented a major challenge, notably the bottom structure supporting the cargo tanks foundation, bearing in mind load considerations.

Floating gantry for bridge construction

Belgian operator Sarens designed a Floating Foundation Installer to transport and position the footings of the new Champlain Bridge in Montreal. The 62m-long, 47m-wide vessel, classed Special Service/Floating Gantry, consists of two barges, connected with an overhead gantry.



Bureau Veritas applied its offshore technical expertise in supporting owners in optimizing OPEX costs and asset integrity. We are leveraging technology to help our clients achieve their aims: from market acceptance of new subsea and marine renewable energy devices via certification, to improved asset integrity through our revolutionary Veristar AIM^{3D} solution.

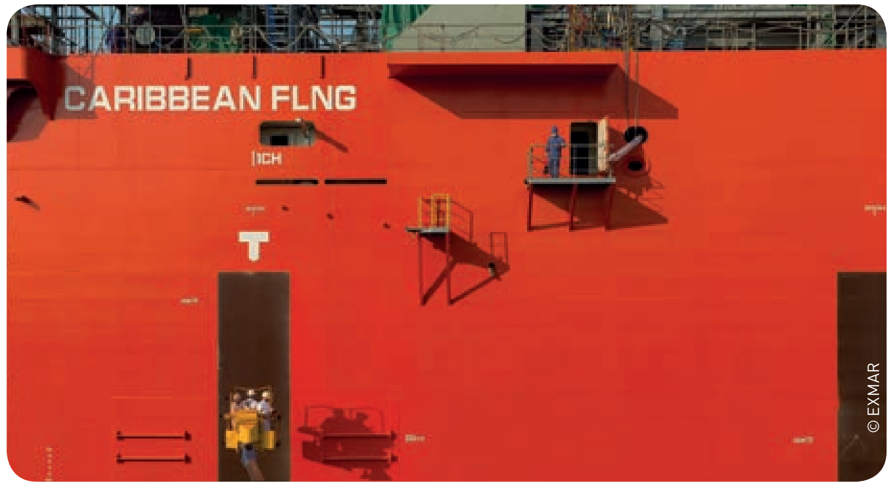
OFFSHORE ACTIVITIES

32 **FLOATING** UNITS
33 **FIXED** UNITS
34 **SUBSEA**
36 **OFFSHORE SERVICE** VESSELS
38 **MARINE RENEWABLE** ENERGY

© Total

Optimizing OPEX

In a difficult market, operators tightened cost control. This primarily meant identifying ways to reduce OPEX, but also commissioning low-cost designs for new projects.



© EXMAR

Exmar's Caribbean FLNG, the world's first FLNG unit, was commissioned and successfully performance-tested in China.

Low oil prices made 2016 an extremely difficult year for offshore floating units. Major investment projects were put on hold: new orders came in the form of smaller, fast-track projects based on standardized designs.

Demand for OPEX services was more resilient, albeit with strong price pressure, as operators sought ways to maximize production at a lower cost. At Bureau Veritas, we responded by rethinking our processes and tools to offer better value and faster service. For example we have begun certifying the approach and methodology for visual inspections using drones.

Digitizing asset integrity management

Our new Veristar AIM^{3D} solution enables us to offer clients holistic asset integrity management. It generates a 3D model of the offshore unit, which is updated throughout the life of the asset with data from sensors and inspections to provide a continually evolving digital twin. In 2016, we launched the tool with selected clients: Total, for its FPSO under construction for the Egina field offshore Nigeria; and PTTEP for Pathumabaha, an existing Floating Storage and Offloading (FSO) unit moored in the Gulf of Thailand.

Frame agreement with FPSO leader

Within the framework of the Fast4ward project, we worked on the new standardized design of SBM Offshore, the market leader in FPSO leasing. We also signed a frame agreement with SBM Offshore covering CAPEX and OPEX services.

Progress on flagship projects and rules

BV-classed projects of industry significance reached major milestones during 2016. Exmar's Caribbean FLNG, the world's first FLNG unit, was commissioned and successfully performance-tested in China. And in Africa, the Moho Nord FPU was installed offshore Republic of Congo, while work continued on conversion of two VLCCs to FPSOs for Total and its partners at the Kaombo field offshore Angola.

We supported industry safety via the publication of rules and guidelines and development of offers. New rules for jackups (NR 534 Self-Elevating Units) and semi-submersibles (NR 571 Column-Stabilized Units) were issued in 2016.

Continued growth in verification

A collapse in new drilling spelled a dearth of fixed CAPEX projects and market consolidation: but verification grew in importance as the EU adopted a Safety Case approach.

The regulatory event of 2016 was the adoption of a UK-style Safety Case approach across the EU, following transposition of the EU Offshore Safety Directive into national laws. The new goal-setting approach requires operators to define their own performance standards, and be provided with a verification scheme.

Verification Academy helps operators get ready

During 2016, Bureau Veritas supported clients in preparing for use of performance standards at its Verification Academy in Aberdeen. The Academy provides training in Independent Verification for clients, Bureau Veritas personnel and regulatory bodies. Overall, 140 people benefited from training to date.

Hess awarded Bureau Veritas the operational verification contract for two fixed platforms off the coast of Denmark. In the North Sea, Shell also renewed its Independent Verification Body (IVB) contract covering 30 UK assets that has been in place for over ten years. The work includes annual operational verification of each asset by site examination visits and onshore maintenance management audits and verification of major changes including decommissioning.

Extending the life of ageing assets in Malaysia

Bureau Veritas supported Malaysian national oil company Petronas in addressing the risks posed by ageing assets that operate beyond the facilities' original design life. These comprise over half the country's installations. We carried out verification, and developed an Ageing & Life Extension (ALE) Framework to embed best practice and specific technical requirements within industry processes.

New offers

With decommissioning rising up the industry agenda, we launched a packaged service integrating desktop studies prior to decommissioning and field assistance during the process. This will be followed with detailed guidelines, to be published in 2017.

BACHO PILONG

SENIOR GENERAL MANAGER, PETROLEUM OPERATION MANAGEMENT DIVISION, MALAYSIA PETROLEUM MANAGEMENT

We are working with Bureau Veritas on an Integrated Operational Asset Integrity Assurance (IOAIA) project. With nearly 400 active facilities, IOAIA will enable us to improve business targets and lifecycle cost, optimizing resources, operations and maintenance. In delivering this strategic program, we require technical capability and quality AIM solutions that go beyond compliance with regulations. Bureau Veritas has provided valuable expertise and industry best approach to assure safe and efficient operations.

© D.R.

Innovation allied with cost control

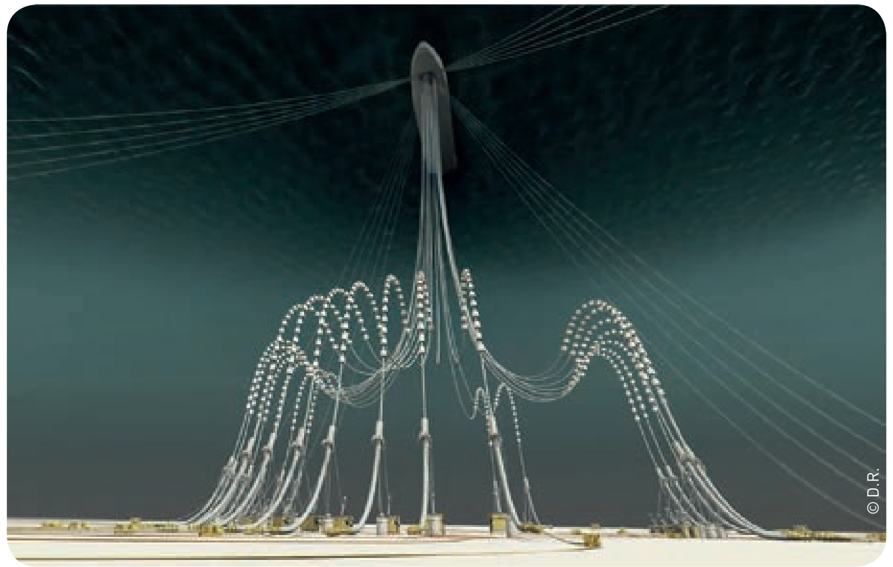
With a long-term trend for equipment and processes to be installed on the seabed, certification of new technologies helped operators achieve their aim of cost optimization throughout the lifecycle.

Low oil prices put a damper on new deepwater projects in 2016, however work continued on major oil projects in the North Sea and West Africa. This notably included Kaombo, the twin FPSO project to be operated by Total offshore Angola, for which Bureau Veritas is certifying the Subsea Umbilical Riser and Flowlines (SURF) components.

Heading into 2017, gas opportunities in the Mediterranean, India and East Africa are emerging, with the subsea industry now capable of implementing a full solution with pipelines to shore.

Optimizing lifecycle cost from design stage

A project for Total aimed to reduce OPEX by assessing the technical criteria that will optimize maintenance costs throughout the lifecycle from design stage. The project focused on trawling interference for a project located offshore West Africa.
A workshop examined ways to estimate the impact of trawling on lifecycle costs, in terms of both repairs and lost production. Bureau Veritas then went on to develop a methodology and complete a technical assessment for use by Total.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Flexible supply certification for BP's QUAD 204

BP's Quad204 project is designed to completely redevelop and maximize production from the Schiehallion and Loyal fields, located 175 km west of Shetland. The project includes a new FPSO and renewal of subsea infrastructure network: a lazy-wave global riser configuration, made with buoyancy modules to absorb vessel motions, and with tethers anchored to the seabed.

Bureau Veritas' role was to certify the 21 dynamic flexible risers and 78 flexible jumpers supplied by TechnipFMC. A dedicated project team was put in place to coordinate design review and inspections. The latter involved overseeing the manufacturing and testing of flexible lines at TechnipFMC's plant, as well as the main ancillary item suppliers in Europe.

Certifying new SPS technology

In 2016, we published our Guide to Subsea Production System (SPS) certification. It responds to two growing trends: the first, for more and more equipment and processes to be installed on the seabed, and the second, for standardization, as operators seek to reduce costs by adopting proven technology.

Our SPS team also worked on qualification and certification of a wide range of new technologies. These included Independent Review Certification for a new Managed Pressure Drilling (MPD) technology for Roxel Products in Norway.

Robotics frame agreement

Bureau Veritas signed a frame agreement certification of new technologies with Cybernetix, a TechnipFMC company.
The agreement covers robots, monitoring systems and auxilliary systems for Remotely Operated Vehicles (ROVs). We are also working on a three-year certification program for IRIS, an inspection robot for flexible lines. IRIS uses non-destructive inspection methods to detect problems such as corrosion, rupture and failure at depths up to 200m with no stop to production. Bureau Veritas certified several parts of the project, and also devised a procedure for certifying robots.

VIRGINIE LEHNING
MARKETING & TECHNOLOGIES COORDINATOR, CYBERNETIX

Cybernetix, a wholly owned TechnipFMC subsidiary , is a specialist in asset integrity monitoring and inspection solutions monitoring and robotics based interventions for subsea and offshore hostile environment. Certification enables us to demonstrate our absolute commitment to quality, performance, reliability and to deliver the best products to support our customers in securing the integrity of their assets. As there are no existing independent standards for monitoring and inspection solutions, we initiated our collaboration with Bureau Veritas. Our aim is to become a reference by benefiting from their in-depth oil and gas industry knowledge and worldwide presence for the certification of our mooring and hull integrity monitoring and inspection solutions.

© BV OSP_40

Optimizing costs, safeguarding systems

In an extremely challenging market marked by oversupply and low charter rates, owners seeking a global network, cost optimization and specific expertise moved vessels to BV class.

The OSV market continued to be impacted by the downturn in oil and gas during 2016, with low utilization and charter rates leading to vessels being put in lay-up or scrapped, and an uncertain hangover of newbuilds. Two niche sectors provided some relief: vessels serving offshore wind projects and the emerging decommissioning market.

Efficient offshore wind solutions

Two orders stood out in offshore wind. A new order of a Service Operation Vessel (SOV) under construction at Cemre for delivery to Esvagt in 2017 features a diesel-electric compact design by Havyard. Able to accommodate up to 22 technicians, it will offer high levels of cost efficiency and environmental protection with a CLEANSHIP SUPER notation.

Another feature of the market is conversions: deploying vessels from the depressed oil and gas market into growing niche segments. In the Netherlands, Bureau Veritas is working with owner Boskalis and crane manufacturer Huisman on the conversion of an existing semi-submersible heavy transport vessel into a crane vessel. The 216m F-class vessel will support a 3,000 metric ton offshore mast crane, to be used for installation of offshore wind turbine foundations.

Wind certification

Bureau Veritas has been working with IMO and North Sea administrations on certification standards for vessels used for wind farm installation, maintenance and operation and high speed crew transfer.

Acta Orion became the first BV-classed wind farm support vessel equipped with a walk-to-work (W2W) motion-compensated offshore access system (OAS). Used for construction and maintenance support, the vessel can accommodate up to 60 technicians and transfer them via an active transfer gangway in sea conditions up to 2.5m significant wave height. It has a large cargo carrying capacity and can work in hatchcoverless "open top" mode. To support the design and safe operation of W2W gangways, Bureau Veritas has published a specific class notation OAS and accompanying certification guidelines (NI 629).

Diving System Safety

In 2016, Bureau Veritas published new rules for the classification of diving systems (NR 610), covering both surface-supplied and saturation diving systems, to complement its 2014 rules for the classification of diving support vessels (NR 609). We also supported Mutawa Marine in becoming the first company in Abu Dhabi to receive the IMO Diving System Safety Certification (DSSC), a requirement recently introduced in the region.

Acta Orion became the first BV-classed wind farm support vessel equipped with a W2W motion-compensated offshore access system.

© Acta Marine

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VESSELS MOVED TO BV CLASS

Cyber systems take center-stage

OSVs are becoming increasingly complex vessels with a high level of automation and system integration, for which software control systems play a key role. Operators need to ensure these systems are fit for purpose in terms of safety, reliability and security.

To support them, Bureau Veritas is partnering with Houston-based Athens Group to provide project de-risking services including hardware-in-the-loop testing (explained in new BV Rule Note NR 632 published) and independent third party verification of complex systems. We also actively contributed to the new IACS requirements for computer-based systems (UR E22), designed to close the regulatory gap for complex onboard systems.

> *"OSVs are becoming increasingly complex and automated with a high degree of integration of software control systems. We have partnered with Houston-based Athens Group to provide project de-risking services."*

Maintaining availability

The value of an OSV lies in its availability, which depends on reliability and maintainability (RAM). To meet the challenge, we are partnering with Airbus subsidiary Apsys to introduce reliability engineering methodologies developed in the aerospace and automotive industries to marine and offshore. The aim is to integrate RAM from the start of the project in order to minimize total cost of ownership and optimize maintenance management.

© D.R.

Multi-purpose/diving support vessel Everest at the Keppel Singmarine shipyard in Singapore for outfitting.

CLAES SKOV JENSEN

FLEET MANAGER – TECHNICAL, ESVAGT

Esvagt provides a wide variety of offshore safety and support services, mainly in the North Sea and the Barents Sea. We have a fleet of 42 vessels including emergency response vessels, multipurpose vessels, SOVs and OSVs. Thirty of these are classed with Bureau Veritas, principally the smaller vessels: we also have a new efficient SOV under construction which will also be BV-classed. We started working with them in the 1980s and they are very close to us: they are strong on theory and good in practice, and if we need urgent assistance, we get it.

A new wave
of developments

Marine Renewable Energy provided a bright spot in the depressed offshore sector during 2016. Bureau Veritas supported development of emerging technologies while continuing to provide certification for the mature fixed offshore wind sector.

© Principle Power

WindFloat, approved by Bureau Veritas.

Marine Renewable Energy (MRE) represents a growing force, buoyed by public sector support. With fixed offshore wind now mature, floating offshore wind gained a vote of confidence in 2016 as the French government launched a call for projects. And 2017 is seen as a crucial year, with increasing demand in Europe, the US and Asia taking the technology from single-unit prototype to pilot farms and one step closer to commercial use.

Certification scheme de-risks MRE

Certification helps emerging MRE move from drawing board to reality by providing stakeholders with confidence that untested technology is safe and performs to specifications. In 2016, Bureau Veritas published a dedicated certification scheme for MRE technologies (NI 631) covering floating offshore wind, current and tidal turbines, wave energy converters (WECs) and ocean thermal energy converters (OTECs).

We are also playing an active role in two technical committees of the International Electrotechnical Commission, aimed at developing internationally recognized standards for wind energy (IEC 61400) and wave, tidal and other water current converters (IEC 62600).

CHRISTIAN CERMELLI

CHIEF NAVAL ARCHITECT, PRINCIPLE POWER

It was important to Principle Power to gain certification of our WindFloat technology, both to ensure we had addressed environmental and human risks and to prove the effectiveness of our technology. Bureau Veritas has a strong reputation and experience in this area. We were impressed by their openness to new technology: they really understood what we were doing and provided very pertinent comments. We have since been selected for a major French offshore wind project and hope to continue to work with Bureau Veritas through ramp-up.

> *“Our MRE certification scheme builds on our offshore engineering experience and understanding of regulatory requirements.”*

Type certification for three new floating technologies

We applied the NI 631 standard and granted Approval in Principle to three projects around the world: a floating foundation for a wind turbine in Europe; a floating OTEC platform for use in the Maldives; and a Chinese WEC.

Bureau Veritas' Approval in Principle of WindFloat Méditerranée covers the second generation of a ballasted floating foundation for a wind turbine, following successful prototype testing in Portugal. Designed by Principle Power, it will be used in a pilot array in the French Mediterranean.

In the Maldives, we provided concept approval for Bardot Group's latest floating OTEC. The 2MW targeted plant will cover 100% of the electricity needs of a planned tourist resort.

Finally in China, we provided concept approval covering structure, hydrodynamics, stability, electricity and machinery for a 100kW WEC prototype built off the coast of Wanshan Islands for the Guangzhou Institute of Energy Conversion.

Ramp-up in fixed offshore wind

In the mature offshore wind sector, two new contracts stood out, both for offshore substation certification in the North Sea.

STX sought certification for Rentel Offshore Wind Farm in the North Sea, a 42-turbine plant that will provide up to 294 MW of power. Spanish owner Iberdrola requested certification for the East Anglia One project, a farm targeting 714 MW of power from 102 turbines. Our role in both projects is to provide assistance in geotechnical design and structural design for the jacket and topside with independent analysis, and other studies including review of the corrosion protection system and fire and safety.

Bureau Veritas also completed work on major wind projects. This included issuing conformity statements for DONG Energy's 450 MW Borkum Riffgrund 2 project in the German North Sea, and providing a range of services to support project certification for E.ON's Rampion wind farm off the UK south coast.

Marine and offshore value-added services that lie outside the scope of classification form a growing part of our offer. In 2016, we further extended these services through two acquisitions, enabling us to serve a wider range of clients and provide specialist support to help them optimize asset performance.

EXPERT SERVICES

42 **MATTHEWS**DANIEL
44 **TMC** MARINE
45 **MAC**
46 **HYDROCEAN**
47 **TECNITAS**

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Loss-adjusting and risk assessment for the energy market

Part of Bureau Veritas since 2014, MatthewsDaniel serves the needs of energy companies and their insurers.

The acquisition of MatthewsDaniel in 2014 provided Bureau Veritas with a platform in the loss-adjusting market and a window to the insurance industry. Principally focused on the oil and gas offshore industries, MatthewsDaniel's loss-adjusting services cover all insured scenarios, whether a major incident involving property damage and business interruption, or an environmental catastrophe producing multiple third party claims. Furthermore, the company's strength in risk assessment supports Bureau Veritas' aim of developing OPEX related activities via access to new markets.

Low oil prices dramatically reduced the volume of CAPEX projects in 2016, with a resulting impact on the MatthewsDaniel's core markets; service providers competed for slices of a smaller pie. Against this difficult backdrop, MatthewsDaniel performed well. In loss-adjusting, MatthewsDaniel reacted to the drop in global CAPEX activity and focused on OPEX related work, successfully gaining appointments on most major loss adjusting projects worldwide. And while risk assessment saw a difficult year, especially in the US due to its reliance on upstream activity in the Gulf of Mexico, activity in the Middle East held up well.

> *"In a difficult market, MatthewsDaniel performed well: whilst risk assessment activity was hit by the global slowdown in CAPEX spend, the business countered this with a solid performance in the loss adjusting arena, where it secured appointments on most of the major assignments globally."*

Noble Mick O'Brien under tow.

© D.R.

New loss-adjusting projects

MatthewsDaniel were appointed on several large claims in 2016, including one of the largest of the year, the FPSO Kwame Nkrumah operated by Tullow Oil on Ghana's Jubilee oil field. Failure of the turret bearing led to an ongoing loss of production. MatthewsDaniel are advising on significant insurance claims relating to both the hull and machinery as well as the resultant business interruption.

Other appointments related to an incident at an E.ON-owned and operated power plant in Siberia insured in the German insurance market, and a fire at ENI's Sannazzaro de' Burgondi oil refinery in northern Italy.

Successful removal of Brazil FPSO

In the wake of an explosion in 2015 on the FPSO Cidade de São Mateus, offshore Brazil, MatthewsDaniel was appointed to manage the claims process, investigate the circumstances of the incident and analyze the cause, as well as to assess the scope of damage and financial impact.
The damaged FPSO was successfully towed to Singapore for repairs in 2016.

Marine warranty and risk assessment

In 2016, MatthewsDaniel was appointed to provide Marine Warranty Survey (MWS) services for multiple subsea tie-back installations including on behalf of Talos Energy LLC, Deep Gulf Energy and Anadarko Petroleum Corporation. This is in line with the industry trend to focus on more cost-effective expansion of assets via subsea tie-backs as opposed to new field developments. The scopes ranged from desktop engineering reviews of installation procedures to attendance for asset loadout, transportation and installation approvals.

Major projects in 2016 included a full scope of MWS services for EOG's Sercan Platform installation offshore Trinidad. The scope included engineering review, attendance for the loadout and transportation of assets from US Gulf Coast to offshore Trinidad and installation attendance for the platform construction campaign, including the subsea flowline.

Another major project involving MatthewsDaniel was MWS for the Upper Zakum 750 EPC-2 Project – Island Surface Facilities which is a US $4 billion contract awarded to Petrofac by Abu Dhabi's Zakum Development Company (ZADCO). The project comprises the construction and commissioning of four artificial islands to include wellhead control, manifolds, crude oil process facilities, water injection and gas lift, oil export pumps, power generation and associated utilities. MatthewsDaniel were also appointed by ZADCO to act as MWS for the loading and transportation of project modules from various fabrication yards across the world and to witness the safe discharge of these modules at the respective islands. More than 170 modules of various sizes and shapes were transported on barges and semi-submersible heavy lift vessels. The project is expected to be completed by mid-2017.

Notwithstanding reduced drilling activity globally, strong relationships also continued to flourish with the major drilling contractors. Circa 400 Location Approvals were issued by MatthewsDaniel during 2016 and there was an increase in the scope of services for several drilling contractors, including review and approval of locations, wet tows, field moves and dry transports.

ROBB ERICKSON

VICE PRESIDENT SALES,
HEAVY MARINE TRANSPORT,
DOCKWISE USA LLC

Today most of Dockwise's certification and classification is entrusted to Bureau Veritas and MatthewsDaniel is its preferred marine warranty surveyor for semi-submersible heavy lift transportations. We can't tell our clients who to use as a marine warranty surveyor. But we can recommend. It is an important role as the link to the marine insurer and we like to work with people who are familiar with semi-submersible ships and the special issues involved. MatthewsDaniel is really experienced with this and it shows, working with them, everything goes much smoother.

Two Noble Eve class MODUs onboard Dockwise Vanguard.

© Dockwise

Extending our services
for insurers

The acquisition of TMC Marine, a company providing pre- and post-casualty technical advice and support to the marine industry since 1979, enables Bureau Veritas to broaden its offering for insurers, shipowners and charterers.

25
NEWBUILDINGS DISPUTES FOR WHICH TMC PROVIDED EXPERT WITNESS SERVICES IN 2016

TMC Marine joined Bureau Veritas in April 2016. With a focus on marine claims and accident investigations, salvage and wreck removal consultancy and marine expert witness services, P&I clubs form its largest client group. New audit services such as navigation audits and suitability audits are expected to expand rapidly in 2017.

Two trends characterized TMC's markets in 2016. On the one hand, the P&I insurance market was quiet, with a reduced number of incidents, accidents and casualties, resulting in fewer claims. On the other, a difficult market context meant that contentious shipbuilding disputes between owners and yards increased sharply during the year: TMC provided expert witness services in over 25 disputes relating to newbuildings mainly in China, Korea and Singapore.

Complex wreck removals

TMC was involved in two high-profile wreck removal projects during 2016. The first was a passenger ferry, the Sewol which sank off the coast of Korea in 2014. Acting on behalf of the Korean government, TMC has provided technical advice during the wreck removal operation to lift the 8,000 ton wreck in one piece from the 45m-deep seabed. The job is expected to conclude in 2017.

The second project was the removal of the TS Taipei, a containership that ran aground off the coast of Taiwan. TMC represented the Swedish Club, P&I insurers who insured the shipowner for the wreck's removal operation.

The project was complex due to its exposed location close to a nuclear power plant, and the requirement to safely remove oil onboard, as well as remove several hundred containers of cargo, before successfully refloating the two halves of the wreck and clearing the site to the satisfaction of the local Taiwanese authorities.

Gas platform jacket removal

A gas platform off the coast of Iran was damaged by contact with a passing vessel, resulting in the need to remove the damaged jacket and surrounding debris field. TMC was appointed as the independent surveyor by a UK-based P&I club who was the insurer for the passing vessel, to oversee the removal works. This role requires significant diplomacy as well as technical skills in overcoming the logistical difficulties.

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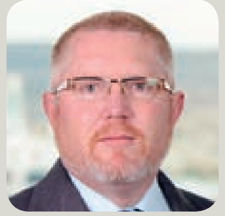


JOHN OWEN

SENIOR CONSULTANT, SWEDISH CLUB, BERNICIA MARINE CONSULTANTS

TMC provides concise advice and really grasps the bigger picture. We chose to work with them on the removal of the TS Taipei partly because of their global presence and the fact they can offer a 24-hour package, but largely because of our previous work on the removal of the Rena off New Zealand. We knew the same team would bring that valuable experience to bear on this complex project; we also understand each others' thoughts, processes and desired outcomes. This mutual understanding helps us resolve situations quickly.

Improving our offshore
OPEX offer

The newest addition to the Bureau Veritas Group of companies brings a broad range of assurance and consulting services for the offshore industry.

The last quarter of 2016 saw MAC join Bureau Veritas. The company provides marine assurance and consulting services, with recognized strengths in dynamic positioning, marine assurance and naval architecture largely focusing on a wide variety of vessel types serving the offshore industry.

Frame agreements recognize quality service

Against a tough market backdrop, MAC's emphasis on high quality service paid off as it gained two major contracts and increased market share.

A three-year contract with BP Exploration, and a five-year contract with Maersk Oil covered marine assurance, dynamic positioning and naval architectural services in support of marine logistics teams at the two companies for the UK continental shelf. The aim: to support BP and Maersk in delivering safe and efficient service to their operations and projects in the North Sea. MAC worked on over 120 individual BP projects in the first nine months of the project across a wide range of OSVs, construction vessels, drilling units and floatels. At Maersk, where the scope also includes marine warranty, MAC completed a MWS scope relating to the decommissioning and removal of a floating asset on behalf of Maersk and Maersk's insurer.

Marine warranty for greenfield project

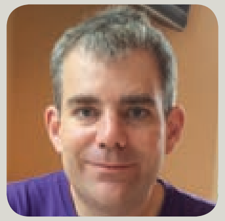
The marine warranty team continued to deliver services to EnQuest PLC in relation to the Kraken Field development, one of the largest greenfield infrastructure projects in the North Sea. 2016 saw the completion of the subsea infrastructure installation: the first part of 2017 will see project completion as the full FPSO is installed and risers completed.

Dynamic positioning leadership

120
SCOPES OF WORK WITH BP IN 2016

MAC reinforced its reputation in dynamic positioning, with technical leadership of the Marine Technical Societies' DP 2017 conference and the equipment subcommittee charged with developing guidance on reactivation of laid-up DP vessels. MAC also continued to support the International Marine Contractors Association (IMCA) as part of the DP focus group within IMCA's marine committee. MAC also completed a number of complex newbuild failure modes and effects analyses for a diving support vessel in Norway, a pipelay vessel in Holland and two semi-submersible DP3 floatels built in China.

© Prosafe



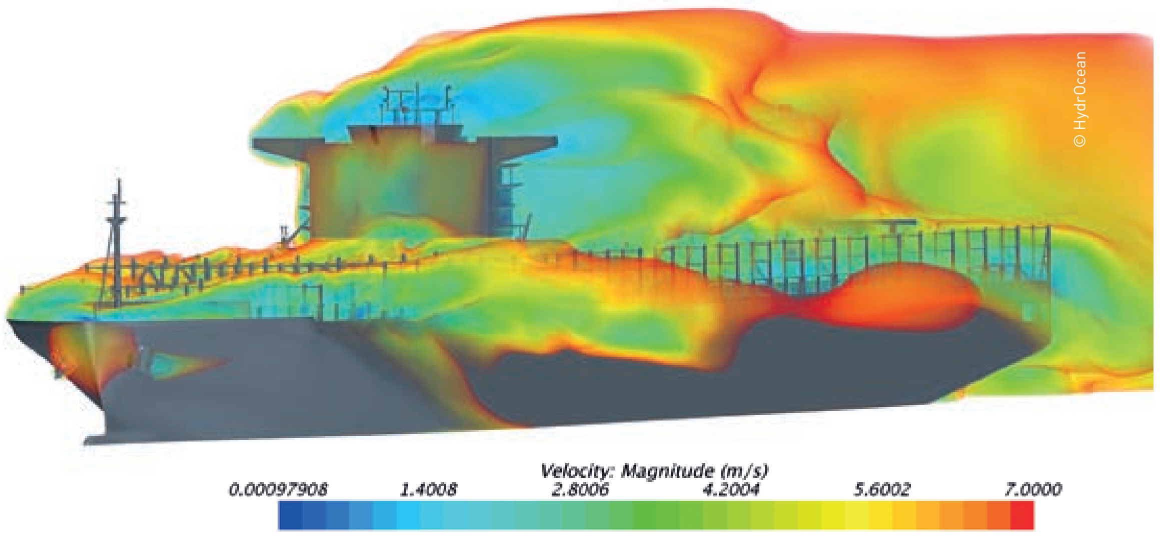
JIM DEXTER

SENIOR MANAGER PROJECTS – CHINA, PROSAFE

Prosafe is a leading owner and operator of semi-submersible accommodation vessels. In 2016, MAC provided Failure Mode Effect and Consequence Analyses (FMECAs) for the Dynamic Positioning and other critical systems on our two new build vessels in China, part of our strategic fleet renewal program. Having worked with MAC previously, we had high confidence in their ability to deliver, ensuring our vessels would perform from their very first job. The first vessel is now on hire and the transition was one of the easiest we have ever experienced.

Computational Fluid Dynamics (CFD)
for efficient designs

HydrOcean provides simulation solutions to evaluate ship and offshore unit design performances quickly, with the ultimate goal of improving ship efficiency.



Containership wind load evaluation for weather routing software.

HydrOcean offers a unique Computational Fluid Dynamics (CFD) platform for the marine and offshore industry. While demand for offshore services and ship efficiency services shrank in 2016, HydrOcean continued to focus on R&D and new service development.

Improved efficiency for ships

Hull optimization is based on the use of CFD and the deformation of an initial ship design in order to automatically evaluate hundreds of different hulls or appendages on a complete operational profile provided by the shipyard or owner. HydrOcean worked on around ten such projects in 2016 for clients in Europe and China, including projects for CMA CGM with reduction of fuel consumption by 5 to 10%.

Other optimization projects were performed in cooperation with Bureau Veritas' Marine & Offshore Advanced Technology Research Center (ATRC) in Shanghai for Chinese designs for tankers, bulk carriers, drillships, OSVs, LNG carriers and, most recently, a livestock carrier.

HydrOcean also supported the French Americas Cup team, with the set-up of numerical models and simulation of forces on the foils used to lift sailing yachts above the water.

First use of innovative wave load simulation

Green water simulations are designed to evaluate the impact of huge waves on a ship or offshore structure. HydrOcean carried out a major project for TechnipFMC: simulating the impact of a 30m-high wave on a FPSO, and evaluating the water forces on deck and equipment. While the methodology had been developed with partners, including TechnipFMC and Total, as part of HydrOcean's research and development program, this was its first industrial application.

Advances in research and development

HydrOcean's strong partnership with the Ecole Centrale de Nantes continues to yield results.

In 2016, HydrOcean joined with Ecole Centrale de Nantes, Bureau Veritas and Nextflow Software to establish an international research chair in hydrodynamics and structures for marine applications. It also made further improvements to its CFD software, taking part in an international benchmark.

Technical expertise
for marine and offshore

A provider of upstream design, modeling and risk services, Tecnitas was impacted by the downturn in new projects; but demand remained for services that improve safety and efficiency throughout the lifecycle.

> *"Identifying the hotspots in terms of stress and fatigue, and illustrating them in a 3D model supported the client in optimizing future inspections."*

Subdued marine and offshore markets led to a reduction in activity during 2016, as owners delayed projects and low oil prices dampened demand for energy efficiency services. Nevertheless, risk services remained in demand, alongside services relating to conversions of ships to dual fuel, and calculations for offshore projects under construction.

Value-add services for marine clients

In a booming market for passenger ships, Tecnitas delivered several alternative designs in 2016. Two related to fire safety for Regent's Seven Seas Explorer, built by Fincantieri: Tecnitas supplied one alternative design on a fire zone with a length of more than 48m, and another on a large fire door. It also provided evacuation studies for Neptun Werft and started three alternative designs on a new STX cruise ship design.

Tecnitas also led an alternative design analysis with GTT, the France-based designer of containment systems with cryogenic membranes, on a gas-fuelled cruise ship concept (G054) fitted with a Mark III LNG tank designed for two barg pressure.

An Inventory of Hazardous Materials (IHM) is one of the requirements of the Hong Kong convention for the safe and environmentally sound recycling of ships. In 2016, Tecnitas carried out three IHMs on MSC containerships. It also provided IHMs to the Royal Saudi Navy.

Supporting major offshore projects

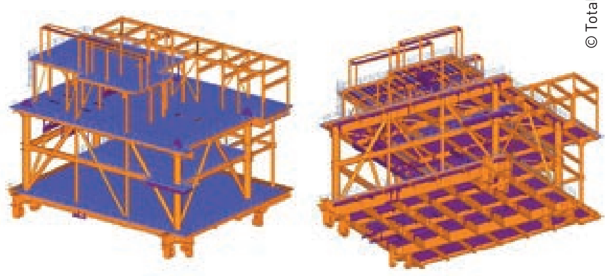
In offshore, Tecnitas' services were called on for landmark projects. It performed yielding, buckling and fatigue calculations for Saipem, which is responsible for the engineering, procurement, installation and commissioning of two converted turret-moored FPSOs for the Kaombo project offshore Angola.

Tecnitas carried out a Written Scheme of Examination (WSE) for the topsides structure of the FPU LIKOUF to be used at Total's Moho Nord field offshore the Republic of Congo by maintenance contractor Cegelec Oil & Gas. A new service, this involved preparing a cost-efficient inspection program by identifying the hotspots for inspection in terms of stress and fatigue, and illustrating them in a 3D model.

MASSIMILIANO ZANNOTTI

SHIP SAFETY PROJECT COORDINATOR
AND REGULATION EXPERT, FINCANTIERI

We worked with Tecnitas for the first time on two alternative designs for the BV-classed Seven Seas Explorer and the outcome was excellent. They provided solid fire engineering knowledge and experience and both alternative designs were completed months before ship's delivery which, from a shipbuilder's point of view, is very important. I would also highlight Tecnitas' synergy with Bureau Veritas: technical support was easily accessible whenever regulatory advice or clarifications were needed.


© Total

Model of the LIKOUF FPU topside structure.

A world leader
in inspection, certification and laboratory testing

Our mission is to help clients worldwide identify, prevent, manage and reduce risks. We provide solutions for their quality, safety, environmental protection and social responsibility requirements. Our employees are proud of their profession. Their impartiality and technical expertise are fundamental assets for Bureau Veritas, alongside the Group's global presence and its broad portfolio of services.

OUR BUSINESSES

Bureau Veritas has an extensive, diversified business portfolio. Our activities are organized into eight global businesses, each specializing in specific industries or service lines:

- Marine & Offshore
- Consumer Products
- Government Services & International Trade
- Industry
- Construction
- In-Service Inspection & Verification
- Certification
- Commodities

1,400
OFFICES AND LABORATORIES WORLDWIDE

OUR CORE SERVICES

Through its various businesses, the Group assists its clients throughout the lifetime of their assets, products, and infrastructure and in the continuous improvement of their processes.

69,000
EMPLOYEES

Testing

Determining a product or material's characteristics in a laboratory or on site.

Testing provides businesses with the confidence that products are safe, of the right quality and conform to specifications and applicable regulations. We perform testing and analysis services in three sectors: commodities, consumer products and industrial equipment. They are carried out by some 400 laboratories.

Inspection

Verifying on site that a product, asset or system meets specified criteria.

Inspection covers a wide range of services designed to reduce risk, control quality and verify quantity, and meet regulatory requirements. This includes visual inspection, verification of documents, manufacturing supervision and electronic and mechanical testing.

Certification

Assurance by an independent accredited body of conformity to specific requirements.

Certification represents a third-party stamp of approval that a product, service or system conforms to specified standards. It can enable companies to enhance their reputation and open up new markets, or simply ensure that they are able to operate. Our certification services cover systems, products and people.

€4.55
BILLION IN REVENUE

Front cover: Christophe de Margerie,
the first ice-breaking LNG carrier designed for the Yamal project.

BUREAU
VERITAS

Move Forward with Confidence

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